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Committee on Tungsten
Twenty-second session
Geneva, 10 December 1990
Item 3(a) of the provisional agenda

DISCUSSIONS OF THE SESSIONAL WORKING GROUP: EXAMINATION OF STATISTICS PROVIDED BY THE SECRETARIAT

List of the different definitions and methodologies used in major tungsten-producing countries

Note by the UNCTAD secretariat

1. At its twenty-first session, the Committee requested the secretariat to prepare a paper, to be examined at its twenty-second session, containing a list of the different definitions and methodologies used in major tungsten-producing countries.1/ This note is submitted in pursuant to that request.

2. On 6 February 1990, a note was sent to States members of the Committee on Tungsten requesting information on the definitions and methodologies used for estimating tungsten mine capacities. In response, the secretariat received two replies, namely from China and Spain. The definition and methodology used in China are included in the annex. The reply from Spain provided that country's views on the definition and methodology used by the United States Bureau of Mines to derive mine capacities. (The definition and methodology of mine capacities, as provided by the United States Bureau of Mines, is reproduced in the annex) In this regard Spain stated that, in principle, the definition used by the United States Bureau of Mines was a good one. However, the Spanish authorities felt it should include a peak capacity and an average capacity and that it would be useful to take into account the long-term and the normal working conditions in each country. In this way, capacity data would become more complete.

3. Other members of the Committee on Tungsten are requested to submit to the secretariat, before the twenty-second session, the information requested on definitions and methodologies used in estimating tungsten mine capacities. Such replies, which are essential to a proper consideration of this item, will be circulated as an addendum to this document.

1/ Cf. report of the Committee on Tungsten on its Twenty-first Session, (TD/B/C.1/TUNGSTEN/82), paragraph 22.

ANNEX

List of the different definitions and methodologies used in major tungsten-producing countries

China [a/]

To estimate the capacity of a mine, these five facilities of the mine are taken into account, namely haulage, transportation, ventilation, drainage and extraction. The capacity of the mine is taken to be equal to the smallest of these five facilities measured in term of their capacities.

United States of America [b/]

Mine capacities are based on the rated capacity for mines and mills. Rated capacity is defined as the maximum quantity of product that can be produced in a period of time on a normally sustainable long-term operating rate, based on the physical equipment of the plant, and given acceptable routine operating procedures involving labour, energy, materials, and maintenance. Capacity includes both operating plants and plants temporarily closed which, in the judgement of the author, can be brought into production within a short period of time with minimum capital expenditure.

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a/ As provided by China Tungsten Industry Association.

b/ As supplied by the United States Bureau of Mines.

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Geneva, 10 December 1990
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REVIEW OF THE DISCUSSIONS, PROPOSALS AND WORK TO DATE ON THE QUESTION OF STABILIZING THE TUNGSTEN MARKET WITH A VIEW TO DETERMINING APPROPRIATE COURSES OF ACTION TO ENABLE THE GOVERNMENTS OF PRODUCING AND CONSUMING COUNTRIES TO BE IN A POSITION TO REACH AGREEMENT ON MEASURES TO STABILIZE THE TUNGSTEN MARKET AND TO ARRIVE AT AN EARLY DECISION ON THE CONVENING OF A NEGOTIATING CONFERENCE

A review of existing research and development programmes to promote new applications for tungsten and a survey of industry and government views on the need for additional programmes

Report by the UNCTAD secretariat

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READEX

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Annexes

I The questionnaire in the version as sent to respondents to collect information for the preparation of the present report

II List of countries which have replied to the request for information

INTRODUCTION

1. The present report has been prepared by the secretariat pursuant to the request made by the Committee at its twentieth session. 1/ At that time, the secretariat gave an oral report outlining the problems that might be encountered in obtaining on a world-wide scale information from enterprises and organizations including in this regard the importance of the secret nature of much such research. The Committee opted for preparation of a questionnaire to collect information and requested that the secretariat seek comments in writing on a draft questionnaire so that any responses from member States might be taken into account before proceeding with the actual collection and analyses of the information. 2/ The secretariat acted accordingly.

2. Details of the approach used in the preparation of the report and the limitations to its coverage are discussed in chapter I. Chapter II focuses on the answers to the questionnaire. It gives most of the details in the form in which they were originally received so that the nature and characteristic of the research and development programmes conducted in some member States could be fully appreciated. Chapter III offers an analysis of the results of the review and survey, drawing on the information and comments of respondents. In chapter IV, some suggestions for follow-up action are provided in the form of conclusions.

3. In retrospect, it appears that the decision to renew efforts to complete the review and survey on research and development programmes has been indeed justified. The results may not be as comprehensive as everybody would have wished but the findings presented in the analysis provide a useful basis for future work on this subject.

I. APPROACH AND COVERAGE

A. The approach and sources of information

4. As indicated above, the draft questionnaire, submitted to the Committee at its last session, was sent to member States for written comments. A number of replies were received, namely from the Economic Commission for Europe, Japan and Spain. No major issue was raised regarding the contents of the questionnaire but some proposals were made to change the text on a number of points. The object was to facilitate responses in view of the fact that some information sought might be subject to certain restrictions for reasons of confidentiality. These suggestions were taken into account in finalizing the text of the questionnaire (annex I).

5. Following the consultative stages, the final version of the questionnaire was sent to respondents for completion before the secretariat could proceed to the next stage: collecting the information and carrying out an analysis. Up to the time of writing, the secretariat had received 13 replies; this does not take into account two, from Brazil and Turkey, which had replied the previous year. Nevertheless, as the latter replies contained relevant information, they have also been included in the analysis presented in this report. Member countries which have transmitted a reply are listed in annex II.

6. The countries responding represent quite a diverse group in terms of such factors as whether they are consumers or producers and with respect to the size and structure of their tungsten industry, which often differs quite substantially from country to country. The diversity would imply differences in interest in research and development for the promotion of tungsten applications in industry, a fact which seems to be reflected in their answers to the questionnaire.

7. Of the 15 countries responding, 8 are producers and 7 are consumers. It may be noted that Argentina is grouped with producers mainly because of its potential as a tungsten producer. While Mexico, Thailand and Turkey export most of their tungsten in the form of ores and concentrates, Brazil currently processes all its concentrates into higher value-added products. In terms of size, Argentina, Mexico and Turkey are among the small producers as measured by production tonnages. By far the largest producer and exporter of tungsten is China, which currently accounts for over half of the world mine production and well over two thirds of world exports of concentrates and intermediate products. Both China and the Republic of Korea produce not only concentrates but also a range of intermediate and finished products. Their interest in research and development is therefore relatively broader compared to other producers.

8. Austria is alone on the consumers' side of this list; it produces a substantial amount of ores and concentrates for domestic consumption. The remaining consumers depend on imported tungsten material, either in the form of concentrates or intermediate products. Both Sweden and the United Kingdom used to produce some tungsten concentrates from domestic mines but these mines are now closed down. The Federal Republic of Germany is the largest consumer to have responded to the questionnaire. In general, consumers appear to be more interested in the product-end type of research and development rather than that at the mining level, a situation which is easily understood given the fact that enterprise-funded research and development is usually linked to potential commercial gain.

B. Limitations in the coverage

9. Some comments are warranted regarding limitations in the coverage of this report, as these may narrow its scope somewhat although they do not invalidate the findings.

10. One main limitation with respect to coverage is that not all the member States responded to the questionnaire. Consequently the analysis is less comprehensive than was desired. Of the 15 countries responding to the request for information, 3 (Japan, Mexico and Poland) for one reason or another have provided no information for the analysis. The countries supplying information represent more than 50 per cent of the Committee members usually attending the Committee sessions. On the basis of available data for 1989, they account for 64 per cent of world production and 43 per cent of world consumption of ores and concentrates. Using these percentages as criteria, the level of response would seem to be acceptable although of course not as high as had been hoped.

11. The extent to which some answers received from respondents were incomplete constitutes another limitation. A number of factors may be responsible for this result, including the confidentiality of some information and the difficulty of gathering material from a large number of sources. For example, the information received from China and the Federal Republic of Germany came mainly from two principal sources, namely Zhuzhou Cemented Carbide Industry Company and Hermann C. Starck Berlin, respectively. It may, however, be noted that these two companies are among the major companies directly involved with tungsten as users and that therefore they reflect major users' interest in research and development in these two countries as far as tungsten is concerned.

12. Another limitation in the coverage of the report arises from the fact that research and development which is directly or indirectly of interest to tungsten cuts across many industries. To the extent that respondents' replies cover only research and development programmes within the tungsten industry alone, there is a major omission possible concerning such industries as the powder metallurgy, electronics and tool-making. Research and development in these industries may have important implications for the use of tungsten in industry but such considerations have been largely disregarded in this report.

13. The report provides useful findings which are elaborated in the body of the text. Moreover, each reply received was valuable in itself for the quantitative and qualitative information it offered.

II. RESULTS OF REVIEW AND SURVEY

14. The information and comments supplied by respondents to the questionnaire appear in the Table which shows the country, and the answer to whether it was positive or negative. The present chapter is divided into two sections each corresponding to the review and survey parts of the questionnaire. The first section covers existing research and development programmes intended to promote new applications for tungsten; this part corresponds to questions 1, 2(a) and 2(b) of the questionnaire. The second section surveys the views of industry and government on the need for additional programmes; this corresponds to question 3 through question 5 of the questionnaire.

Table

Answers provided by respondents to questions 1 to 5 of the questionnaire

Question / Country	1	2(a)	2(b)	3	4	5
Argentina	o	-	o	-	-	-
Austria	o	-	X	X	X	o
Brazil	X	X	o	X	-	-
China	X	X	X	X	X	o
France	o	-	o	X	X	o
Germany, Federal Republic of	X	a/	-	-	b/	o
Korea, Republic of	X	X	X	X	X	o
Spain	X	X	X	X	X	o
Sweden	o	-	o	o	o	o
Thailand	o	-	o	X	X	X
Turkey	o	-	o	-	-	-
United Kingdom	X	X	X	X	o/X	o

Source: Information provided by respondents to the questionnaire.

Note: o indicates a negative answer, X a positive answer, o/X a partly negative and positive answer, while the dash - denotes information not relevant or not available.

a/ Respondents unable to furnish details for reasons of confidentiality.

b/ Response to questions 3 and 4 combined in one answer (see also footnote 5).

A. Review of existing research and development programmes to promote new applications for tungsten

(i) Answers to question 1: "Is your company or organization involved (a) independently or (b) jointly in any research and development projects to promote new applications of tungsten?"

15. Most respondents who filled in the questionnaire have replied to question 1. There were six negative answers, namely from Argentina, Austria, France, Sweden, Thailand and Turkey. Of the remaining replies, the answer was "yes" for at least part of the question. This was so for: Brazil; China; Germany, Federal Republic of; Republic of Korea; Spain; and United Kingdom. From the replies, it would appear that few research and development programmes were being conducted jointly either at the domestic or international levels. Details were given in some of the replies.

16. The respondent from China indicated that his company (Zhuzhou Cemented Carbide Industry Company) attached high importance to the development of tungsten technology and the use of new processes and new equipment to improve product quality. The company did not rely only on its own technological capabilities, but had also marshalled the scientific and technological contribution of several high level educational institutions and research establishments of renown in China, working with them jointly to improve the quality of hard alloys in a national effort to solve technological problems associated with the development of new products. The company paid great attention to the importation and adaptation of advanced foreign science and technology. For example, the company had imported advanced tungsten-smelting and hard-alloy production technology from the United States and Sweden. As a result of these efforts, product standards had reached an advanced international level while the level of production technology had attained the advanced levels found abroad in the 1980s. The company was generally interested in any current research and development work, seeking to broaden the uses and applications of tungsten; it would be willing to organize or take part in further research and development activities to this end.

17. The respondent from the Federal Republic of Germany indicated that, as one of the world's largest manufacturers of tungsten products, it sustained continuous research and development efforts in the interest of promoting tungsten consumption.

18. The reply from Spain was positive to both parts (a) and (b) of question 1. As regards part (b) of the question, joint research and development were being conducted with CEIT (Centro de Estudios e Investigación Técnica de Guipúzcoa) and la Sdad. UGICARB-MORGON and CERMET (Centre Européen de Recherche Metallurgie des Poudres) of Grenoble (France) through a DRITE programme for the development of new materials.

19. The reply from Turkey indicated that some research and development had been conducted between 1977-1981, mainly for the development of tungsten ores; currently there were no research and development programmes either in the public or private sector aimed at new applications for tungsten.

20. The respondent from the United Kingdom noted that the information given covered two companies. One of the companies was conducting independent research and development but neither one was conducting joint research and development projects.

(ii) Answers to question 2(a): "If your company or organization is involved in any such projects, please indicate (i) the number of projects, (ii) the application of tungsten concerned, (iii) the time horizon of each project and (iv) the size of the project in terms of global budgetary resources."

21. As this question is tied to the answer to question 1, it is relevant to affirmative replies to the previous question. Information and comments have been received from: Brazil; China; Germany, Federal Republic of; Republic of Korea; and United Kingdom.

22. The reply from Brazil indicates that two projects have been undertaken in the public sector and one in the private sector. Of the public sector projects, one was being carried out chiefly by the Centre for Mineral Technology (CETEM) which is interested in the processing of Brazilian tungsten ores; and the other project was being conducted by the Department of Chemistry of the University of Sao Paulo which has been studying the organometallic chemistry of tungsten through its derivatives. In the private sector, Paulo Abid Engenharia S.A. has been developing projects on the assessment of tungsten ore resources as well as undertaking research and development activities in the mining and processing of the mineral.

23. The reply from China mentions the following research and development projects or programmes as being conducted to promote the use of tungsten:

(a) Introducing advanced techniques and equipment to effect a technological transformation of the out-dated production system (hard alloys section);

(b) Developing and researching new uses for tungsten compounds;

(c) Developing new applications for hard alloys;

(d) More intensive processing of hard-alloy, tungsten and molybdenum products;

(e) Opening up new applications for tungsten and molybdenum products;

(f) Creating high-purity products and developing applications for them;

(g) Development of super-fine powder metallurgy and applications for it.

24. In the reply from the Federal Republic of Germany, the respondent indicated that for reasons of secrecy, no details could be furnished regarding sub-sections (i), (ii), (iii) and (iv) of the question.

25. The answers from the Republic of Korea for the respective subsections are: (i) three projects; (ii) the applications concerned are tungsten wire, tungsten carbide tools (including research and development in CVD and PVD coatings), and tungsten powder-making (sintered tungsten parts); (iii) the time horizon is 1991-1995; and (iv) the investment is approximately $US 400-500 million per project.

26. The reply from Spain provides the following answers for the respective subsections of the question: (i) two projects; (ii) new groups of hard metal alloys and boride alloys; (iii) one project over the time-horizon 1989 to 1993 and one from 1989 to 1990; and (iv) the size is approximately 1,000,000 ECUs for one project and 200,000,000 pesetas for the other. 3/

27. The United Kingdom's reply indicates that the two companies which have forwarded responses are engaged in continuous research and development of new applications for tungsten in the form of cemented tungsten carbide, particularly for wear-resistant and mining products. The typical times for the development of new products through design production and marketing would be one and a half to two years. The annual budget for this type of work would be typically £200,000. 4/

(iii) Answers to question 2(b): "Are you conducting any research projects which could lead to substitution of tungsten by other materials? If so, please provide responses to question 2(a) above for such projects."

28. This part of question 2 sought information on research and development projects with negative effects on tungsten demand as opposed to the positive effects elicited in the first part of the question. There were six "NO" responses to this question: from Argentina, Brazil, France, Sweden, Thailand and Turkey. One reason given for the absence of projects was that the current low tungsten prices provided little incentive for consumers to replace tungsten by other materials. A "yes" response was given by a number of countries including: Austria, China, Republic of Korea, Spain and United Kingdom. Detailed information was provided with the "yes" response from: China, Republic of Korea and United Kingdom.

29. The following research and development projects or programmes were reported in the reply from China:

(a) Research into and manufacture of coated tool bits;

(b) Research into and manufacture of ceramic materials;

(c) Developing applications for cermets (Ti (C,N));

(d) Research into diamond-cutting tools and tool coatings;

(e) Promotion of stainless alloys (Fe-TiC, Fe-WC).

30. In the reply from the Republic of Korea, the answers to the respective sub-sections of the question are: (i) one project; (ii) cermets and ceramics (TiCN base materials); (iii) for the time horizon 1986 to 1995; and (iv) approximately $US 1,500 million.

31. The United Kingdom reply mentions that one company was involved in up-dating and monitoring the existing know-how in order to assess the impact of substitution on tungsten products as well as on the growth potential of substituted products. The other company had no specific projects under way aimed at substitution of tungsten by other materials, although in its work to complement the use of cemented tungsten carbide this might occur.

B. Survey of industry and government views on the need for additional research and development programmes

32. The last three questions of the questionnaire are particularly relevant to this survey. Despite differences of views among respondents, the results generally favoured more research and development projects for promoting new applications of tungsten in industry, and advocated international co-operation, giving a number of suggestions.

(i) Answers to question 3: "Do you believe there is a need for additional research and development programmes for the promotion of tungsten in industry applications? Please elaborate on your answer, as appropriate

33. There was only one negative answer to this question. The need for additional resources for research and development was reflected in the responses of Brazil and Thailand which both cited depressed prices as the main factor giving rise to this need since low prices impinge on research and development efforts. An affirmative answer was also given by: Austria, China, France, Republic of Korea, Spain and United Kingdom. 5/ A number of replies elaborated on the matter.

34. In the reply from China there was an indication that additional research and development programmes were needed for the following purposes:

(a) To find new applications for tungsten to stimulate the tungsten market and rectify the current weakness in the market;

(b) To broaden and expand the industrial applications for tungsten, leading to increased productivity;

(c) To meet the need for high-technology development;

(d) To develop tungsten products with a higher valued-added component; to increase the economic return; to improve the terms of trade, and to make the most of China's advantage in tungsten resources.

35. In elaborating on the reply, the respondent from the Republic of Korea commented that there was a need for additional research and development programmes for some products using high purity tungsten (e.g. semi-conductors, sputtering targets, fluorescent powder, special reagents and catalyzers).

36. The reply from France stated that the consumption of primary tungsten was decreasing in traditional applications. The principal causes given included scrap recycling, and tool coatings which improve tool performance per unit. Additional research and development programmes were seen as a means to find ways to compensate for these decreases.

37. The United Kingdom reply indicates that the two companies supplying information for the questionnaire saw a need for additional research and development programmes. Examples included: finding wider applications for the use of cemented tungsten carbide including the potential substitution of tungsten for other products. Greater publicity was advocated regarding the desirable properties of this material for engineering applications. Moreover, research and development work must aim to make the best use of tungsten industrially. Examples would include optimization of existing tungsten products in response to competition from other materials.

(ii) Answers to question 4: "Would you favour co-operative international research and development programmes for tungsten? If yes, please comment as appropriate on the conditions required to make such programmes feasible and attractive

38. The question of co-operative international research and development programmes did not obtain consensus although it scored high in "yes" responses. In several cases the comments accompanying the replies reflected some of the problems surrounding international co-operation on research and development. Replies in favour of co-operative international research and development programmes for tungsten were received from Austria, China, France, Republic of Korea, Spain and Thailand. There was one "no" reply (Sweden) and one reply containing both positive and negative elements (United Kingdom). The reply of the Federal Republic of Germany included comments but gave no indication of whether it was in favour of or against such programmes.

39. Despite a "yes" response, the respondent from Austria felt that it would be difficult to co-ordinate such development work or to make it effective and economical.

40. Speaking in favour of international co-operation, the respondent from China suggested that such co-operation could take the following forms:

(a) The organization of international co-operative research and development programmes, at the initiative of the company, as appropriate, on a chosen or assigned topic(s);

(b) Participation by the company in international co-operative research and development programmes conducted by other countries;

(c) Research and development work in international co-operative programmes divided on the basis of topics among the participants and conducted through an active exchange of knowledge and periodic visits among research partners.

41. In elaborating on the question, the reply from France placed research and development of new applications for tungsten in a context broader than just individual enterprises. In order to establish efficient programmes, international co-ordination was viewed as necessary between the relevant

Government ministries and professional associations as well as involving the International Tungsten Industry Association in all research and development activities relating to tungsten from mining to the manufacturing of finished products.

42. The respondent from the Federal Republic of Germany pointed out that tungsten producer associations had made renewed efforts in recent years to identify possibilities for promoting tungsten consumption through additional research and development efforts, for example, the Primary Tungsten Association which has ceased to exist while the International Tungsten Industry Association was active in this regard. The topic has formed a subject for discussion at various international tungsten symposia. However, nothing tangible had evolved as yet from the talks that had taken place.

43. The respondent from the Republic of Korea thought that a mutual exchange of technical information and supportive research and development funds should follow so as to make co-operative international research and development programmes feasible and attractive. Commenting on the same matter, the respondent from Spain noted that if an agreement were reached on co-operative international research and development programmes, it should be because such programmes were mutually beneficial to participants.

44. The reply from the United Kingdom indicated that of the two companies which had supplied information for the questionnaire, one company would welcome closer contacts with users and potential users at an international level as this would be helpful in establishing joint projects. The other response called for non-co-operative research and development programmes.

(iii) Answers to question 5: "Do you believe your company or organization will change the focus or level of research and development investments related to tungsten in the future? If you do, please elaborate as appropriate."

45. This question sought to assess the commitment of countries to future research and development investment both to promote tungsten applications and to promote substitutes. There was almost unanimity among respondents: no change in either the focus or the level of research and development investments was foreseen at least in the near future.

46. In Thailand where no research and development programme was presently being conducted, the respondent indicated that the Thai Government might take into consideration research and development investment in future if Thai tungsten production were to increase significantly.

47. The reply from Austria indicated that an Austrian company was involved in development programmes for hard metal application only, with research being mainly limited to quality improvements and industrial economies.

48. In elaborating on his reply, the respondent from France added that the research programme of his company was oriented particularly towards scrap recycling, development of new product grades and improved production processes. Research into new applications for tungsten would require efforts and resources beyond the means of his company.

49. The respondent from China noted that his company could meet basic conditions to undertake research and development work as follows:

(a) Research facilities were available (a research laboratory and a pilot project workshop);

(b) There was co-ordinated set-up for analysis and control;

(c) Factory back-up existed;

(d) A guaranteed supply of technical personnel;

(e) Accumulated experience in dealing with the problems of organizing scientific research.

He added that what was needed was supportive funds.

50. The respondent from the Republic of Korea commented that there would be no sharp change in the focus or level of research and development investment related to tungsten within five years. Thereafter, the question would be reconsidered in the light of market conditions.

51. In the reply of the United Kingdom, there was a comment that one company had attempted to identify "niche" applications of tungsten, concentrating on optimizing specific grades of tungsten products. It was in this area where most of their research and development efforts were concentrated. The effort is supported by both internal resources and through collaboration with European research establishments (universities, etc.).

III. ANALYSIS OF RESULTS

52. The foregoing paragraphs have aimed to show that the review and survey in this report have not only provided useful information on the research and development programmes in several countries, but have also indicated some interesting findings. Although the number of respondents was limited these findings tend generally to confirm the direction of research and development, which is not entirely unknown in the tungsten industry.

A. Analysis of review results

53. The review part of the report drew attention to quite a wide range of interest in research and development in each country. This interest reflects such factors as whether the country is a producer or consumer, the size of its production or consumption, its level of industrial development and the level of industrial integration.

54. From the replies received, it would appear that research and development efforts were limited in such developing countries as Argentina, Brazil, Thailand and Turkey. The current low prices of tungsten and the relatively small size of their tungsten mining industry have seriously constrained the availability of research and development funds in these countries. On the basis of past or existing programmes, their research and development efforts were generally concerned with such mining aspects as improving mining productivity and the extraction or processing of complex ores.

55. Research and development to promote new applications of tungsten have been pursued in countries with a significant interest in tungsten either as a tungsten producer or consumer, or as a supplier/exporter of tungsten products. Among these countries are: China; France; Germany, Federal Republic of; Republic of Korea; Spain; and United Kingdom.

56. Of the above countries, China and the Republic of Korea are important producers of tungsten as well as significant suppliers/exporters of tungsten products. In China, enterprises such as the Zhuzhou Cemented Carbide Industry Company possess the facilities and technical skills to undertake research and development programmes on a continuous basis. In the Republic of Korea, research and development to promote tungsten applications were given high priority and accounted for some of the larger investments in this field.

57. The remaining research and development programmes reported by respondents had been conducted in the developed market-economy countries. Like many large tungsten consumers, Hermann C. Starck Berlin organized its own research and development on a continuous basis. Some research and development was reported in Spain and the United Kingdom but the size of the investment was relatively small. It may also be noted that no research and development programmes have been reported by respondents from Austria and Sweden although these two countries were significant consumers of tungsten as well as suppliers and/or exporters of tungsten products.

58. Another major finding of the review of existing research and development programmes was that programmes to promote new applications of tungsten and to develop substitution of tungsten by other materials were sometimes pursued concurrently. At first sight, this approach might appear inconsistent, but a more careful examination reveals that it is pursued mainly in those cases

where the respondents were interested in exploring products further downstream in the chain of production. Their research and development programmes seeking substitution of tungsten by other materials were concerned with improving productivity and technical performance of their products rather than simply substitution of one material by a cheaper material. This finding also indicates that research and development to develop substitution of tungsten by other materials will remain a challenge for tungsten demand despite the considerably reduced price incentives to replace tungsten which prevailed for example some years earlier.

59. It would have been interesting to compare the size of investment in each type of research and development programme. However, there was very little information available except from the Republic of Korea where the investment in research and development to promote new applications of tungsten was significantly higher than that leading to the substitution of tungsten by other materials. This situation may not be true in those countries where investments in research and development for promoting tungsten applications have been relatively small.

60. In the replies some reasons have been indicated for the lack or inadequacy of investment in research and development to promote new applications of tungsten. The reasons include uncertainties regarding the return on the investment and high investment costs which are often beyond the means of individual enterprises. In one or two cases there was some evidence to suggest that the type of research and development leading to the substitution of tungsten by other materials or a reduction of tungsten demand continues to be pursued in a number of enterprises. Although slackening recently, the effects of such research and development on future tungsten demand may not be entirely negligible.

B. Analysis of survey results

61. On the survey part of the questionnaire, respondents overwhelmingly saw a need for additional research and development programmes for tungsten. This confirms what has often been regarded as a weak point of the tungsten industry: too few new substantial tungsten applications have been developed in recent years. According to the suggestions made, it would seem that there is room for additional research and development programmes in a number of areas, including the greater use of tungsten in high-technology industries, improvements in productivity, wider applications for tungsten products, including high-purity tungsten and cemented tungsten carbide powders, as well as the development of new tungsten products as substitutes for other products. Given the high costs of research and development programmes, a number of respondents regarded the scarcity of funds as the major stumbling block.

62. As for international co-operation on research and development, there was also a high degree of unanimity in favour of co-operative international research and development programmes. This result was not wholly unexpected, taking into account the need for additional research and development resources in many countries, as well as the limited research funds available at the national level in some countries. Furthermore, the present low prices of tungsten has highlighted the potential benefits of research and development leading to a greater use of the material in industry.

63. The areas indicated as offering prospects for international co-operation on research and development include a mutual exchange of technical information followed by the establishment of supportive research and development funds, and the setting up of joint projects, either bilaterally or multilaterally. It may be noted that there appeared to be areas of overlap among research and development programmes in different countries. Thus, the development of applications for hard metal alloys was being pursued in: China, Republic of Korea, Spain and United Kingdom. Such an overlap may point to opportunitues for co-operation on some programmes on a joint venture basis at bilateral or multilateral levels.

64. However, there is some grounds for caution with regard to co-operative research and development programmes. According to past experience, international discussions to this end have so far been unsuccessful. 6/ As shown by the review, there is little evidence to suggest that co-operative research and development programmes are very common even at the national level, not to mention the international level. One difficulty raised in this regard was co-ordination of research and development co-operation so as to render it effective and economical in an area which may involve substantial commercial gain.

65. Finally, the survey shows that, at least in the short run, no major change in the focus or level of research and development investments related to tungsten was likely. This finding would indicate that while commitments of research and development investment were not expected to diminish in many countries such investment would probably remain at the same current, albeit inadequate, level. As shown by recent experience, this situation was not favourable for the tungsten industry.

IV. CONCLUSIONS

66. Research and development of new applications for tungsten can lead to a strengthening of demand for the product and thus contribute to increased market stability. The need for research and development is paramount, given the fact that few substantial new applications have been found for tungsten in recent years while, at the same time, substitution had led to the replacement of tungsten by other materials. In the light of the analysis presented in the previous chapters, it would seem useful to consider what possible follow-up action would foster research and development efforts in the tungsten industry, taking into account the suggestions made by the respondents. The follow-up actions proposed below are tentative and are not exhaustive.

67. The present report provides a useful basis for evaluating the extent of development programmes. Completion of the data base is nevertheless vital; those member States of the Committee and their enterprises which have not yet replied to the questionnaire are urged to do so.

68. As indicated by virtually all respondents, no major change was expected, at least in the short run in either the focus or the level of investments in research and development programmes. Bearing in mind this situtation, it would seem important to establish or strengthen co-operation at the bilateral or multilateral levels in order to support individual research and development programmes. Some suggestions have been made in this regard in the replies, but in the light of past experiences some caution is also advisable.

69. Science and technology would not be what they are today had there been no exchange of information across national boundaries. This is an aspect of co-operation which is absent in the tungsten industry. Following the suggestions made by some respondents, it would seem useful to consider what steps might be taken to establish a system of contact points. A first step could be to draw up a list of names and addresses in industry and government at the national level. This would establish who could be contacted in areas of mutual interest for exchanging research and development information. A further step might be to set up an information service responsible for collecting, assembling and disseminating information as well as monitoring progress in research and development.

70. Because of the limited resources available for research and development, particularly in developing countries, it was suggested that a research and development fund should be created. Another possibility suggested was to establish joint research and development projects; in this way research and development costs could be shared among the partners. These proposals should be examined also with a view to mobilizing more funds for research and development, a need recognized by many respondents.

71. An international symposium on research and development issues might also be considered. It would be worthwhile in particular to discuss questions related to international co-ordination of research and development efforts and international co-operation for cost sharing, the funding of research projects and other such areas where co-operative action might be possible. In this regard, the Committee on Tungsten might make a useful input by placing greater emphasis on research and development in its work and by involving in its discussions industry experts with experience in research and development.

Notes

1/ See: Report of the Committee on Tungsten on its twentieth session, TD/B/C.1/TUNGSTEN/78, paragraph 38.

2/ See: Report of the Committee on Tungsten on its twenty-first session, TD/D/B/C.1/TUNGSTEN/82, paragraph 38.

3/ An amount equal approximately to $US 1,200,000 and $US 2,000,000, respectively, at the prevailing rates of exchange.

4/ Or $US 360,000 at the prevailing rate of exchange.

5/ The response from the Federal Republic of Germany combines questions 3 and 4 of the questionnaire but seems to be more related to the latter question and consequently the comments appear in paragraph 42.

6/ It may be recalled that the question of establishing an institute of research for tungsten was mooted during discussions at the Third International Tungsten Symposium (see Proceedings of the Third International Tungsten Symposium, Madrid, May 1985, pp. 230-231).

ANNEX I

The questionnaire in the version as sent to respondents to collect information for the preparation of the present report

Question 1

Is your company or organization involved (a) independently or (b) jointly in any research and development projects to promote new applications of tungsten?

Question 2

(a) If it is involved in any such projects, please indicate:

(i) The number of projects;

(ii) The application of tungsten concerned;

(iii) The time horizon of each project;

(iv) The size of the project in terms of global budgetary resources.

(b) Are you conducting any research projects which could lead to substitution of tungsten by other materials? If so, please provide responses to question (a) above for such projects.

Question 3

Do you believe there is a need for additional research and development programmes for the promotion of tungsten in industrial applications? Please elaborate on your answer as appropriate.

Question 4

Would you favour co-operative international research and development programmes for tungsten? If yes, please comment as appropriate on the conditions required to make such programmes feasible and attractive.

Question 5

Do you believe your company or organization will change the focus or level of research and development investments related to tungsten in the future? If you do, please elaborate as appropriate.

ANNEX II

List of countries which have replied to the request for information

Producers	Consumers
Argentina a/	Austria
Brazil	France
China	Germany, Federal Republic of
Korea, Republic of	Japan b/
Mexico b/	Poland b/
Spain	Sweden
Thailand	United Kingdom
Turkey	

Note: In the case of China, France and the Federal Republic of Germany, the information covers mainly Zhuzhou Cemented Carbide Industry Company, Eurotungstène Poudres and Hermann C. Starck Berlin, respectively.

a/ Argentina is considered as a potential producer although it produces only small amounts of tungsten at present.

b/ Countries which have replied to the secretariat but provided no information.